EXECUTIVE SUMMARY

SITE DESCRIPTION AND HISTORY

The Boeing Company's (Boeing's) Auburn Fabrication Division Plant (Boeing Auburn Plant) has conducted aircraft parts manufacturing operations in Auburn, Washington since 1966. Activities at the Boeing Auburn Plant include various operations such as airplane skin and spar manufacture, machine fabrication, tooling, developing emergent products, welding, sheet metal work, process assembly, and other work related to manufacturing airplane tools and parts.

Past manufacturing practices at the Boeing Auburn Plant have led to inadvertent releases of chemicals. The volatile organic compound (VOC) trichloroethene (TCE), previously used in manufacturing operations at the Boeing Auburn Plant, is present in groundwater throughout most of the Site. Smaller releases of metals and petroleum hydrocarbons have also occurred in localized areas; however, TCE and its degradation product vinyl chloride (VC) are the primary constituents of concern because of their widespread distribution in groundwater at the Site and relative toxicity.

In 1987, the Boeing Auburn Plant was issued a Resource Conservation and Recovery Act (RCRA) Permit for treatment, storage, and handling of hazardous waste. The RCRA permit also included requirements for corrective action related to releases of hazardous substances into the environment. Corrective action is being implemented under an Agreed Order between Boeing and the Washington State Department of Ecology (Ecology) issued in 2002 and amended in 2006. In 2006, a new state dangerous waste permit was also issued solely for corrective action, since hazardous waste treatment and storage operations are no longer conducted. The Agreed Order identified solid waste management units (SWMUs) and areas of concern (AOCs) that required further investigation and outlined a process consistent with the Model Toxics Control Act (MTCA) to conduct a remedial investigation (RI) and feasibility study (FS), and prepare a cleanup action plan. The purpose of the RI is to collect sufficient data to define the nature and extent of releases from the Boeing Auburn Plant and to develop and evaluate remedial action alternatives in the FS. The RI report presents collected data and analysis of the nature and extent of releases.

The Boeing Auburn Plant originally occupied approximately 380 acres, but portions of the property have been sold over time and the current extent of the property is approximately 210 acres. The northern 41.9 acres, termed Area 1, were sold to AMB Corporation (now Prologis). Former solid waste management units (SWMUs) and Areas of Concern (AOCs) in Area 1 were a source of the TCE groundwater plumes. The source areas in Area 1 have undergone cleanup, but TCE is still present in groundwater downgradient; Area 1, therefore, remains subject to the corrective action requirements of the state dangerous waste permit and is included in the permit definition of the Facility. The term Facility is used throughout this document to collectively describe the Boeing property (all property currently owned by Boeing) and Area 1.

Boeing completed various investigation and cleanup activities (corrective actions) at the Facility prior to issuance of the Agreed Order. Beginning in 2003, Boeing began work on a comprehensive RI to investigate SWMUs and AOCs at the Facility. A series of investigations and interim cleanup actions were conducted at the Facility in 2003 through 2009. In 2009, Boeing discovered that groundwater contamination had moved off of the Boeing property. A series of iterative investigations to evaluate the extent of two groundwater plumes emanating from the Facility ensued, culminating in 2015 with completion of the groundwater monitoring well network and delineation of the groundwater impacts both on and off Boeing property. Site-wide surface water and air quality investigations were also conducted between 2009 and 2015 to evaluate additional exposure pathways. The term Site is used throughout this document to describe all contiguous property affected by releases of hazardous substances that originated at the Facility, including areas both on and off the Facility that are impacted by groundwater contamination.

HYDROGEOLOGIC CONCEPTUAL MODEL

Groundwater at the Site is the primary media of concern and contamination of groundwater has resulted in two large, low concentration (TCE concentrations no more than 15 micrograms per liter [µg/L] and VC concentrations less than 10 µg/L) plumes that extend more than a mile downgradient from their source areas. A thorough and robust understanding of the Site hydrogeology is critical to understanding contaminant fate and transport within the groundwater plumes.

The Site lies within the Auburn valley formed during the Vashon glaciation approximately 14,000 years ago. Approximately 7,500 years ago an eruption of Mount Rainier sent a large lahar (the Osceola Mudflow) down the valley. The Osceola Mudflow deposited a low porosity layer of sands and gravels suspended in a silt and clay matrix. This layer forms the aquitard below the present day upper alluvial aquifer of the valley.

The upper alluvial aquifer is comprised of deposits from the White and Green Rivers. The deposits consist of highly variable but predominantly coarse alluvial sands and gravels with occasional interbedded silt layers consistent with a relatively high energy, dynamic, alluvial depositional environment. Finer grained deposits and peat, indicative of a lower energy depositional environment are more prevalent in the northwest portion of the Site (toward the valley wall), where smaller water courses and overbank flooding probably contributed more significantly to the deposition. As a result, the northwest portion of the Site generally has higher concentrations of organic carbon in the aquifer.

Contributions to groundwater in the upper aquifer primarily consists of infiltration from the White River with a smaller contribution from precipitation. In general, groundwater throughout the valley flows from the south (White River) to the north (Green River). Locally at the Site, groundwater flow has a pronounced westerly component driven by groundwater discharge zones associated with stormwater features, wetlands, and Mill Creek to the northwest of the Boeing property.

Groundwater velocities vary across the Site due to the heterogeneity of the alluvial deposits. Seepage velocities across the Site are estimated to average approximately 300 feet per year. These relatively high seepage velocities reflect the relatively high hydraulic conductivity of the alluvium and the high rates of recharge to the aquifer system due to infiltration from the White River.

Groundwater is generally shallow with groundwater depths near the Facility in the range of 8 to 22 feet (ft) below ground surface (bgs). In the northwest portion of the Site, groundwater depths are shallower and generally range from 0 to 10 ft bgs. Differences in the depth of the water table across the Site are primarily due to changes in ground surface elevation.

Seasonally, groundwater elevations fluctuate on average approximately 5 ft. Somewhat larger fluctuations are generally observed at the Facility and smaller fluctuations are generally observed in the northwest portion of the Site where groundwater is also shallower.

For the purposes of investigation and discussion, groundwater within the upper aquifer is divided into three zones, a shallow zone that ranges from the water table to 35 ft bgs; an intermediate zone that ranges from 35 to 75 ft bgs; and a deep zone that ranges from 75 ft bgs to the contact with the Osceola Mudflow (generally between 80 and 105 ft bgs).

Geochemistry of the groundwater is an important influence on contaminant fate in groundwater. Chloroethene compounds such as TCE can be biologically degraded through microbial activity under anaerobic (reducing) oxidation-reduction (redox) conditions. Under reducing conditions, microbial activity can degrade chloroethene compounds breaking them down sequentially from TCE, to dichlorethenes, to VC, and eventually to ethene and carbon dioxide. Each step of the breakdown process requires progressively greater reducing conditions within the aquifer.

Aquifer conditions vary across the Site due to the heterogeneity of the alluvium and varying amounts of organic carbon present in the aquifer. At the Facility, mildly to highly reducing aquifer conditions are present as demonstrated by varying concentrations of iron, sulfate, and methane. Further west, the aquifer conditions generally become more reducing as demonstrated by the increased presence of ferrous iron and methane, this is most likely due to increased concentrations of organic carbon in the aquifer.

In general, aquifer conditions at the Site are conducive to *in-situ* (in place) breakdown of TCE to the non-toxic end products, ethene and carbon dioxide. However, the distribution of mid-pathway and end products varies indicating a degree of heterogeneity in the degradation rates across the Site.

CONCEPTUAL SITE MODEL

To assist in understanding the potential for exposure to contaminated media at the Site, Boeing developed a Site conceptual model that takes into account sources of contamination, transport mechanisms, points of exposure, and routes of exposure. Identified source areas are located in the

central to north portion of the Facility and are related to release of contaminants to soil and groundwater at or near the ground surface. Transport of contaminants from the source areas occurs through leaching and dissolution of contaminants into groundwater and soil gas. Downgradient of the source areas, advection via groundwater flow is the primary transport mechanism; vaporization of contaminants from groundwater into soil gas is also a transport mechanism, but appears to be minor based on soil gas measurements and relatively low concentrations of contaminants in groundwater at the water table. Soil contamination outside of the Facility source areas has not been identified.

For exposure to occur, a receptor must come in contact with contaminated media and the contaminants must enter the body (i.e., touching soil, drinking water, breathing air). Soil and groundwater at the Facility is covered by pavement or buildings and potential exposure would only occur during construction or subsurface exploration activities. Groundwater at the Facility is not used for drinking water (all water is supplied by a municipal drinking water system). Air testing has confirmed that contaminants in soil gas are not making their way into the buildings tested or ambient air in measureable concentrations. While there may be potential for exposure to occur during future temporary construction or remediation work, there are no complete exposure pathways for receptors at the Facility (i.e., receptors are not currently being exposed to contaminants at the Facility).

Outside of the Facility, potential exposure pathways include contact with contaminated groundwater, surface water, or air. Groundwater outside the Facility is not used for drinking water (all water is supplied by a municipal drinking water system). Contact with contaminated groundwater would only occur during construction or subsurface exploration activities. Concentrations of contaminants below health-based screening levels are present in several surface water features (stormwater ditches and ponds) where workers or children may have incidental contact with the water; adverse health effects are not expected from contact with surface water. Air testing in commercial and residential buildings outside of the Facility, indicates that migration of contaminants from groundwater to indoor or ambient air is not adversely impacting air quality. Inhalation of indoor air impacted by vapor intrusion is an incomplete exposure pathway, but could occur in the future if conditions change. While there are potential exposure pathways, site evaluation has determined that there are no complete exposure pathways, meaning human exposure to contaminants at the site is not occurring at levels expected to cause adverse health effects.

Boeing evaluated the need for a terrestrial ecological evaluation (TEE) in accordance with MTCA. TEEs address potential impacts on terrestrial plant and animal receptors from contaminated soil. The Site qualifies for an exemption from TEE because contaminated soil is located only on the Facility and all areas with contaminated soil are paved or covered by buildings. Boeing plans to place institutional controls on their property limiting future land use in compliance with the TEE exemption.

SCREENING LEVELS

Boeing developed screening levels for all detected constituents in soil, groundwater, surface water, and air at the Site. Screening levels were developed using MTCA Method B for unrestricted land use and in accordance with applicable sections of MTCA. Where insufficient information was available to develop screening levels using MTCA Method B; MTCA Method A was used (e.g., petroleum hydrocarbons). With Ecology approval, health risk-based screening levels for some surface water bodies were developed using modified equations that account for direct contact, inhalation, and ingestion (as opposed to ingestion only). Screening levels are used in the RI to evaluate exposure pathways and indicator hazardous substances, but screening levels are not necessarily reflective of final cleanup levels. Screening levels were used to evaluate all RI and pre-RI data.

REMEDIAL INVESTIGATION AND RESULTS

RI investigation at the Site focused on four main areas:

- Investigation of SWMUs and AOCs at the Facility that were identified as needing additional investigation in the Agreed Order (Facility investigation),
- Investigation of Site-wide groundwater impacts including downgradient areas off Boeing property,
- Investigation of surface water, and
- Investigation of air (vapor intrusion investigation).

Results of the investigations indicate that impacts are primarily to groundwater, with minor impacts to soil and surface water; impacts to indoor or ambient air from vapor intrusion do not appear to be a concern. Contaminants of concern are primarily TCE and VC due to their relative toxicity and wide distribution in groundwater at the Site. At the Facility, localized areas of petroleum hydrocarbons and metals contamination in groundwater and soil are present in addition to TCE and VC in groundwater.

Facility Investigation

RI investigation at the Facility included SWMUs and AOCs identified in the Agreed Order as needing additional investigation. Two SWMUs (S-15a and S-16) were combined and are collectively designated as AOC A-13 for analysis in the FS. Pre-RI investigations and data (if available) were also reviewed in assessing each SWMU and AOC. Soil and groundwater data collected at all but three of the Facility SWMUs and AOCs did not indicate a release, or a release did occur but was successfully remediated. At these SWMUs and AOCs, further investigation and cleanup is not required and they will not be carried forward to the FS.

At three AOCs, evidence of a release was encountered during the RI, which will require further evaluation in the FS and cleanup. These are summarized below.

AOC A-13 17-06 Petroleum Hydrocarbon Soil and Groundwater Contamination

Petroleum hydrocarbons in soil and groundwater were identified on the east side of Building 17-06 near well AGW128. The petroleum hydrocarbon contamination was originally believed to have originated from the aluminum chip conveyance system and briquetter or associated indoor machine sumps (SWMU S-15a/S-16). However, more recent forensic investigations provide evidence that the structures associated with the aluminum chip conveyance system and briquetter are not likely the source of the release. The source of these petroleum hydrocarbon detections is unclear; as a result, this area has been identified as a separate AOC (A-13) to address petroleum hydrocarbon contamination in the area. Petroleum hydrocarbon concentrations in groundwater above screening levels persist and minor amounts of residual non-aqueous phase product in the groundwater smear zone may be causing concentrations to persist.

AOC A-01 Former Underground Storage Tanks TAU-01 and TAU-02

Petroleum hydrocarbon impacts identified in soil and groundwater west of Building 17-06, originated from two former 10,000-gallon fuel underground storage tanks (USTs); one of the USTs was a diesel tank used to power emergency generators and the other UST was a gasoline tank. Petroleum hydrocarbon concentrations in groundwater above screening levels persist in a localized area and minor amounts of residual soil impacts near the former tanks may be causing concentrations to persist.

AOC A-09 Acid Scrubber Drain Line Leak

Releases of metals were associated with a leak from the acid scrubber drain line on the south side of Building 17-07 at AOC A-09. A partial remediation of the area was conducted prior to the RI; however, soil samples collected after the remediation indicated that cadmium, copper, lead, and cyanide were left in place above screening levels. Groundwater in one monitoring well at this AOC continues to exceed the screening level for cadmium. Nickel concentrations have dropped below screening levels at all wells. Groundwater sampling for cyanide and copper was discontinued in 2000 and 2004, respectively, because concentrations were below screening levels. However, screening levels for both compounds have changed and collection of additional groundwater data is recommended in order to verify current concentrations of copper and cyanide.

Site-Wide Groundwater (AOC A-14)

Site-wide groundwater was added as an additional AOC to the Facility AOCs listed in the Agreed Order. The Site-wide groundwater AOC (A-14) comprises the two large groundwater plumes (Area 1 plume and Western plume), as well as groundwater concentrations less than 2.0 µg/L upgradient of the plumes. The plumes are relatively dilute, with current (December 2015) maximum TCE concentration of 12 micrograms per liter (µg/L) and most concentrations less than 5 µg/L. However, the plumes are extensive, reaching approximately a mile downgradient from the source areas at the Facility. The plume geometries are relatively complex as a result of complex source histories, aquifer

heterogeneity, and complex boundary conditions affecting groundwater flow. Additionally, there is evidence to suggest that sources not associated with the Facility are possibly contributing to the northern extent of the plumes. Contaminant distribution (TCE and VC) within the plumes is also relatively complex, primarily as a result of aquifer heterogeneity and varying redox conditions affecting degradation rates.

Source Areas

The source of the Area 1 plume has been identified as a former TCE vapor degreaser and tank line in former Building 17-05 (currently the Prologis warehouse) that was located at the north end of the Facility. The TCE vapor degreaser was removed in 1979 and TCE use at the Facility significantly diminished around the same time. Historical TCE concentrations in groundwater near the degreaser and tank line were as high as 5,460 µg/L from a temporary boring and 1,433 µg/L at an RI monitoring well. In 2004 through 2005, Boeing conducted an interim remedial action (IRA) to clean up the Area 1 plume source. The IRA consisted of injecting electron donor amendments into the subsurface to enhance reductive dechlorination of TCE. The IRA was effective in reducing source area concentrations of TCE and breakdown products. TCE shallow zone groundwater concentrations at the Area 1 source are currently below the analytical detection limit. Continued slow declines in VOC concentrations in wells located downgradient (north to northwest) of the source area are expected as natural aquifer flushing occurs due to upgradient groundwater recharge and downgradient groundwater discharge.

The source of the western plume is more complex, but appears to be mainly attributed to the Building 17-07 TCE vapor degreaser formerly located in the tank line area at the south end of Building 17-07. It is also possible that other sources in and near Building 17-07 contributed to the release including a former chrome waste holding tank that received condensate from the former TCE vapor degreaser and the former north lagoon adjacent to Building 17-07 that received process water effluent from the chrome waste holding tank. These features are all relatively close in proximity and are collectively referred to as the western plume source area. TCE use in the vapor degreaser ceased in 1976, as a result, the chrome waste holding tank also presumably did not receive TCE-impacted condensate from the degreaser after 1976. The north lagoon was removed in approximately 1985, but the potential for discharge of TCE-containing process water to the lagoon presumably decreased significantly with the decrease in TCE use at the Facility in the late 1970s. The structures involved in these releases have been removed and current groundwater quality trends indicate that mass within the source area has declined based on groundwater TCE and VC concentrations (less than 5 µg/L and less than 4 µg/L, respectively).

Although both the Area 1 and western plumes have identified source areas at the Facility, contamination in the source areas is relatively depleted and does not appear to be making significant ongoing contributions to the plumes (due to the Area 1 IRA, the age of the releases, and significant natural flushing of the aquifer that occurs). The concentration trends indicate that the original

releases were probably not that extensive and currently, the highest groundwater concentrations are downgradient of the source areas. These factors indicate that cleanup of the plumes would be most effectively addressed as a Site-wide strategy and that additional cleanup in individual source areas is not necessary.

Plume Stability and Mass

Boeing evaluated concentration trends and overall plume stability of both plumes combined. Monitoring and Remediation Optimization System (MAROS) statistical modeling software was used to evaluate concentration trends at individual wells and also to evaluate mass trends within the plume.

For the individual well trend analysis, the entire available TCE and VC data sets (including pre-RI data) were used for each well. Concentration trends were analyzed in MAROS using the Mann-Kendal statistical test. Results indicate that the vast majority of wells have statistically stable or decreasing TCE and VC trends, or TCE and VC were not detected. Less than 10 percent of wells showed potentially increasing concentration trends. For wells with potentially increasing concentration trends, further examination of the time series data was conducted to evaluate whether historical trends may be influencing the statistical outcome. When recent data was examined and the Mann-Kendal statistical test was applied over a shorter, more recent timeframe, all wells that previously had statistically increasing trends showed decreasing or stable trends.

Plume stability of the dissolved contaminant mass was evaluated in MAROS by analyzing trends in total plume mass over time and changes in the center of mass over time. The mass trend analysis indicates that the plume mass is stable in all groundwater zones except in the intermediate zone where TCE mass is decreasing. Evaluation of the center of mass over time indicates that the location of the center of mass has remained stable over the last 4 years, indicating that the plume does not appear to be expanding or moving downgradient. Overall, the mass trends and center of mass analysis indicate that the plume is stable. This characterization is consistent with the age of the plumes and attributes of the contaminant distribution, and supports the conclusion that concentrations within the plume are expected to decrease over time.

Surface Water (AOC A-15)

Surface water quality was evaluated at surface water features throughout the Site including stormwater collection and control features, wetlands, and streams. The investigation included both seasonal and longer-term temporal evaluation. Contaminant impacts related to the groundwater plumes from the Facility appear to be confined to stormwater collection and control features present in Algona and southwest Auburn. No contaminants of concern were detected in Mill Creek or the Auburn Environmental Park wetlands. Additionally, analysis of pore water collected from below Mill Creek indicates that contaminants do not appear to be present in the groundwater directly discharging to the creek. Concentrations of constituents of concern were not detected in surface water at the Site above the applicable health-based surface. However, screening levels developed

based on health risk assessments may not reflect the final cleanup levels that will be developed during the FS. Surface water contamination will be carried forward to the FS for evaluation based on final cleanup levels. For the purpose of cleanup, Site-wide surface water quality is designated as a separate AOC (AOC A-15). AOC A-15 is defined by areas where constituents of concern are detected in surface water and the area of Mill Creek directly downgradient of the groundwater plumes.

Vapor Intrusion

Air quality was investigated throughout the Site to determine if VOC-contaminated groundwater was impacting indoor air, ambient air, or other air spaces through vapor intrusion. Investigations were completed on Boeing property and also in commercial and residential areas off Boeing property. Based on the investigations completed to date, exposure to VOCs as a result of vapor intrusion does not appear to be occurring in any area of the Site. No further indoor air evaluation is recommended at the Site and indoor air will not be carried forward to the FS. Results from ongoing groundwater monitoring will continue to be evaluated to ensure that conditions do not change.

SUMMARY OF IMPACTS AND NEXT STEPS

Data collected during the RI and associated investigations is sufficient to characterize the nature and extent of releases from the Facility and to develop and evaluate cleanup action alternatives for the Site in the FS. Three Facility AOCs plus the Site-wide groundwater and Site-wide surface water AOCs are proposed for FS evaluation. Cleanup action alternatives at Facility AOCs will primarily focus on remediation of petroleum hydrocarbons and metals. TCE and VC impacts to groundwater at the Facility will be addressed as part of the Site-wide groundwater AOC. Site-wide surface water will be evaluated in the context of cleanup levels, which will be developed during the FS.